Prevalence of anemia in children 6–59 months old in the state of Pernambuco, Brazil

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ABSTRACT

Objective. *To determine the prevalence of anemia in children 6–59 months old in Pernambuco, a state in northeastern Brazil, so as to help guide health and nutrition policies there.*

Methods. *In 1997 a representative sample of 777 young children had their hemoglobin concentration measured. The sampling process was in three stages. First, 18 municipalities were randomly selected to represent the state and its three geographic areas (metropolitan region of Recife, urban interior, and rural interior). Next, using census lists, 45 census sectors were randomly chosen. Finally, 777 children aged 6–59 months old were selected. Blood was collected by venipuncture, and hemoglobin was measured with a portable hemoglobinometer. In the analysis, prevalence was weighted to reflect the census age distribution.*

Results. *The prevalence of anemia among children 6–59 months old was 40.9% for the state as a whole. Prevalence in the metropolitan region of Recife was 39.6%, and it was 35.9% in the urban interior. The rural interior had the highest prevalence, 51.4%. Prevalence was twice as high in children aged 6–23 months as among those 24–59 months old, 61.8% vs. 31.0% ($\chi^2 = 77.9$, P < 0.001). The mean hemoglobin concentrations in the younger and older age groups were 10.4 g/dL (standard deviation (SD) = 1.5) and 11.4 g/dL (SD = 1.4), respectively. There was no statistically significant difference between the sexes in terms of prevalence.*

Conclusions. *This is the first statewide assessment of anemia prevalence among young children in Brazil. Given the very high prevalence of anemia among the children studied in Pernambuco, especially those in the age group of 6–23 months, public health interventions are needed.*

Key words Anemia, iron, hemoglobin, child health, Brazil.

Iron deficiency anemia is a public health problem in both developing and industrialized countries, and more than 2 billion people around the world are estimated to be anemic (1).

Iron deficiency anemia adversely affects health, cognitive development, school achievement, and work performance. While prevalence data in Brazil are limited, reports from rural Pernambuco (2), rural Bahia (3), urban Paraíba (4), and the city of São Paulo (5) indicate that 35% to 40% of young children are anemic. In the city of São Paulo, trend data reveal an increasing prevalence of anemia despite improved environmental conditions and health care and a decreasing prevalence of malnutrition (5, 6).

The northeast of Brazil—which includes the state of Pernambuco—is the

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poorest region in the country and thus may be expected to have the highest anemia prevalence. This study was conducted to determine the prevalence of anemia in Pernambuco and its three geographic areas in order to guide health policy and future interventions. The study focused on the prevalence in a representative sample of children 6–59 months old.

SUBJECTS AND METHODS

Location

Pernambuco has an area of approximately 100 000 km^2 and a population of over 7 million, of whom 10% are children under 5 years of age (7). Infant mortality in Pernambuco is much higher than the national rate, 58.2 vs. 34.6 per 1 000 live births, and illiteracy among those aged > 15 years is twice the national figure, 26.4% vs. 13.3% (7).

The population of Pernambuco is predominantly urban, residing primarily in and around the capital of Recife or in smaller cities and towns in the interior of the state. On the east, the state borders on the Atlantic Ocean, and in that part of Pernambuco the climate is hot and humid, with sugar cane constituting the most significant crop. Among sugar-cane workers and their families, living conditions are poor, wages are low, and amenities are few, and those persons have little opportunity to grow their own food. In the towns in the interior, small businesses provide employment, and there are local light industries. Moving westward in the state, the climate becomes increasingly dry, and most families are subsistence farmers who struggle to eke out a livelihood in the harsh conditions. During times of drought, many migrate to Recife, which is a busy industrial city on the Atlantic coast and a popular tourist destination with extremes of affluence and poverty. Pernambuco's geographic and socioeconomic diversity is reflected in considerable differences in the quality of life within the state, with the rural areas having the worst health and nutrition indices (8). Malaria is not found in northeastern Brazil and thus does not contribute to the anemia prevalence there.

Study design and data collection

The data were collected during February–May 1997. The survey was cross-sectional, and the sample was representative of the state of Pernambuco and its three geographic areas: the metropolitan region of Recife, the urban interior, and the rural interior.

Subject selection. Sampling was carried out in three stages (9). The first stage was proportional systematic random sampling, in which 18 out of a total of 178 municipalities were selected to reflect the population distribution of the state. For the second stage, the census sectors in each municipality were separated according to their urban or rural designation, and a total of 45 census sectors (out of 2 655) were selected by systematic random sampling. There were 16 sectors in the metropolitan region of Recife, 17 in the urban interior, and 12 in the rural interior. Each census sector had approximately 200 households. Finally, households in each selected sector were visited to identify children aged 6–59 months old. The starting point in each sector was randomly determined from the census map, selecting one block at random and then one corner of that block, also at random. Then, in a clockwise direction, households were visited one by one until the required sample was selected. A total of 777 children were selected, averaging 17 per sector.

Blood collection. Permission of the mother or other custodian was first sought for blood collection. Venous blood was collected from an antecubital vein by trained fieldworkers. The hemoglobin concentration was measured with a portable hemoglobinometer (HemoCue Ltd, Sheffield, United Kingdom), following the manufacturer's instructions.

Ethical considerations. This study had the approval of the Ethical Committee of the Federal University of Pernambuco. Children diagnosed as anemic were treated for 6 months by the research team with 3 mg elemental iron (as sulfate)/kg/week and referred to their local clinic for continuing treatment.

Data analysis

Anemia was defined as a hemoglobin concentration < 11g/dL, grouped as follows: severe anemia, < 7.0 g/dL; moderate anemia, 7.0 to 8.9 g/dL; and mild anemia, 9.0 to 10.9 g/dL (10). We divided the age range of 6–59 months into five subgroupings, and we weighted the overall prevalences for the state and for each of the three geographic areas according to the actual population of children in these age bands as reported in the census for the state (7).

In the statistical analyses, differences for categorical variables were assessed by the chi-square (χ^2) test, and the χ^2_{trend} was used for linear trend. For these tests the unweighted prevalence values were used. For continuous variables, the t test and one-way analysis of variance (ANOVA) were used to test for significant differences in means, and linear regression was applied to test for linear trends. Statistical significance was taken as $P < 0.05$. The statistical software package used was Stata version 5.0 (11).

RESULTS

Prevalence of anemia

Table 1 shows the prevalence of anemia by age, sex, and geographic area. Overall, 40.9% of the children studied were anemic. The highest prevalence was in the rural interior (51.4%), and this was substantially higher ($\chi^2 = 13.77$, $P < 0.001$) than in the metropolitan region of Recife (39.6%) and the urban interior (35.9%).

The prevalence of anemia in children 6–23 months old was twice as

TABLE 1. Prevalence of anemia by age group and sex for the state as a whole and for geographic areas, Pernambuco, Brazil, 1997[a]

	Geographic area							
	Recife metro region		Urban interior		Rural interior		State overall	
	Children in subgroup (No.)	Anemia prevalence (%)	Children in subgroup (No.)	Anemia prevalence (%)	Children in subgroup (No.)	Anemia prevalence (%)	Children in subgroup (No.)	Anemia prevalence (%)
Age group (months)								
6–11	46	71.7	46	54.3	43	79.1	135	67.3
12–23	79	58.2	78	55.1	84	66.7	241	58.8
24–35	49	44.9	43	23.3	56	57.1	148	38.8
36–47	59	23.7	44	22.7	32	21.9	135	22.9
48–59	45	13.3	35	34.3	38	34.2	118	25.8
	$\chi^2 = 47.98$	$P < 0.001$	$\chi^2 = 22.19$	$P < 0.001$	$\chi^2 = 35.66$	$P < 0.001$	$\chi^2 = 93.56$	$P < 0.001$
6–23	125	63.2	124	38.9	127	70.9	376	61.8
24–59	153	27.4	122	42.6	126	41.3	401	31.0
	$\chi^2 = 35.77$	$P < 0.001$	$\chi^2 = 20.86$	$P < 0.001$	$\chi^2 = 22.50$	$P < 0.001$	$\chi^2 = 78.89$	$P < 0.001$
Total [a, b]	278	39.6	246	35.9	253	51.4	777	40.9
Sex								
Male	141	43.3	131	38.9	123	56.1	395	45.8
Female	137	43.8	115	42.6	130	56.2	382	47.6
	$\chi^2 = 0.01$	$P = 0.93$	$\chi^2 = 0.34$	$P = 0.56$	$\chi^2 = 0.00$	$P = 0.99$	$\chi^2 = 0.26$	$P = 0.61$

[a] For age and geographic area, prevalences were weighted according to the actual population distribution in Pernambuco, as shown in census data for the state (7).
[b] Statistical difference between geographic areas: $\chi^2 = 13.77$, $P < 0.001$.

high as among children aged 24–59 months, 61.8% vs. 31.0%. The decreasing trend with age was significant ($\chi^2_{trend} = 9.86$, $P < 0.001$), and was found in each of the three areas. Anemia prevalence was similar in boys and girls.

Hemoglobin concentration

Table 2 shows the mean hemoglobin concentrations by age, sex, and geographic area. The overall mean value in children aged 6–59 months was 10.9 g/dL. The mean value in the rural interior was 10.6 g/dL, compared with 11.0 g/dL for the metropolitan region of Recife and 11.2 g/dL for the urban interior. The overall mean hemoglobin concentration was 1.0 g/dL higher in children aged 24–59 months than it was among the younger children in the study. The trend test by age was highly significant ($t = 11.55$, $P < 0.001$).

Figure 1 shows the distribution of hemoglobin concentration by geographic area. For children in the rural interior, the curve is shifted to the left by about 0.5 standard deviation (SD) units.

The weighted prevalence of moderate anemia was 10.6% in the rural interior, and 6.0% in the two other areas. For severe anemia, the weighted prevalence was 1.3% in the rural interior and 1.1% in the metropolitan region of Recife. No child in the urban interior was severely anemic.

Figure 2 shows the distribution of hemoglobin concentration for the two age groups, 6–23 months and 24–59 months. For the younger children, the curve is shifted to the left by almost 1 SD. The prevalence of moderate anemia in the younger group was 14.7%, and it was 5.2% in the older group. For severe anemia, the prevalence in these two respective age groups was 1.2% and 0.5%.

DISCUSSION

The 40.9% overall anemia prevalence that we found among Pernambu-

can children is a public health concern. Of particular note is the prevalence of 51.4% in the rural interior, versus 39.6% in the metropolitan region of Recife and 35.9% in the urban interior. The main reasons for the differences we found between rural and urban areas are likely to be: a) lower consumption of heme iron in rural areas due to poverty, limited rearing of livestock, and poor distribution networks for meat and other animal products and b) lower consumption of vitamin C in rural areas where local fruit and vegetable production is constrained by arid conditions or, in the case of sugar-cane workers, lack of land rights, which precludes domestic food production (8). Sanitation and water supplies are poor in rural areas (8), so higher rates of infections and parasitic diseases can also be expected (8, 12).

Anemia prevalence was twice as high in children 6–23 months old compared to those aged 24–59 months, and similar findings have been reported by others (5, 13, 14). Iron requirements are related to growth velocity and so

TABLE 2. Mean hemoglobin concentration (g/dL) and standard deviation (SD) by age group and sex for the state as a whole and for geographic areas, Pernambuco, Brazil, 1997

| | Geographic area | | | | | | | |
| | Recife metro region (278 children) | | Urban interior (246 children) | | Rural interior (253 children) | | State overall (777 children) | |
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age group (months)								
6–11	10.0	1.3	10.8	1.2	9.6	1.5	10.1	1.4
12–23	10.8	1.5	10.6	1.4	10.1	1.6	10.5	1.5
24–35	10.7	1.8	11.6	1.0	10.8	1.2	11.0	1.5
36–47	11.7	1.3	11.8	1.5	11.7	1.2	11.7	1.4
48–59	12.0	1.1	11.6	1.5	11.5	1.2	11.7	1.3
	$F = 15.55$	$P < 0.001$	$F = 8.61$	$P < 0.001$	$F = 17.02$	$P < 0.001$	$F = 35.4$	$P < 0.001$
6–23	10.5	1.5	10.7	1.3	9.9	1.6	10.4	1.5
24–59	11.4	1.6	11.7	1.6	11.2	1.3	11.4	1.4
	$t = -5.34$	$P < 0.001$	$t = -5.80$	$P < 0.001$	$t = -7.15$	$P < 0.001$	$t = -10.30$	$P < 0.001$
Total	11.0	1.6	11.2	1.4	10.6	1.6	10.9	1.6
Sex								
Male	11.1	1.7	11.2	1.6	10.6	1.5	11.0	1.6
Female	11.0	1.5	11.2	1.3	10.5	1.6	10.9	1.5
	$t = 0.57$	$P = 0.57$	$t = -0.11$	$P = 0.90$	$t = 0.45$	$P = 0.75$	$t = 0.88$	$P = 0.38$

FIGURE 1. Distribution of hemoglobin concentration by geographic area, Pernambuco, Brazil, 1997: metropolitan region of Recife (MRR), urban interior (UI), and rural interior (RI)
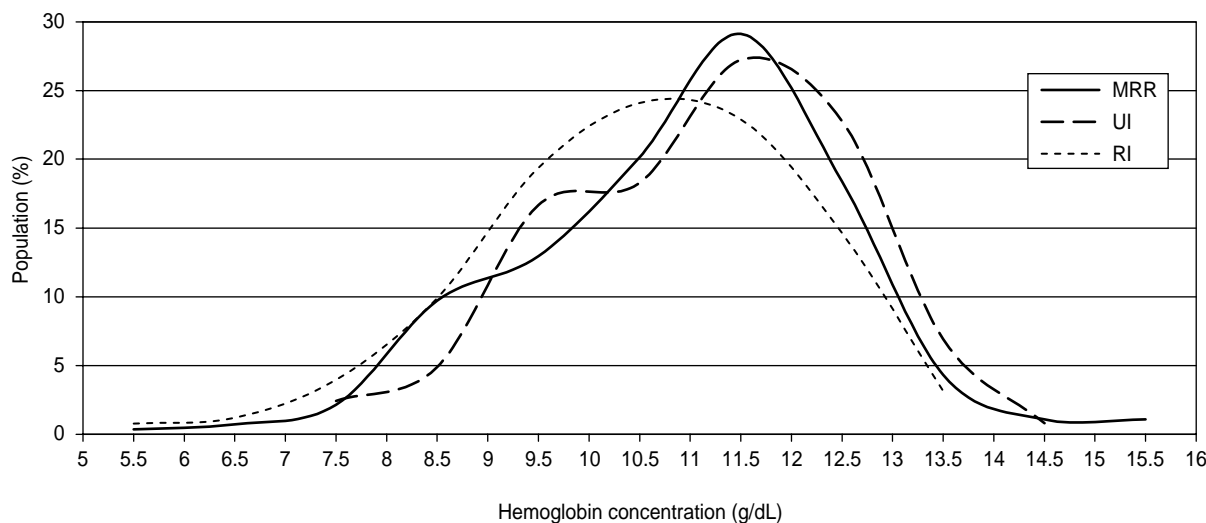

requirements per kg of body weight decrease with age. Therefore, there may be a physiological explanation for the fall in anemia prevalence with age. Iron intakes are also likely to improve with age as a result of a more varied diet, including the introduction of meat and other heme-containing foods.

Infections depress iron absorption (15), and the prevalence of infections is less in older children (16). Thus the significant decline in anemia prevalence with age in this Pernambuco population is highly credible.

Whether a single cutoff of 11 g/dL is appropriate for all age groups is de-batable, and some investigators have called for age-specific cutoffs (17). In "normal" populations—in which defi-ciencies of iron, folate, and vitamin B_{12} have either been excluded or are un-likely—measurements of hemoglobin concentration give median values for young children of about 12.5 g/dL and

FIGURE 2. Distribution of hemoglobin concentration by age, Pernambuco, Brazil, 1997
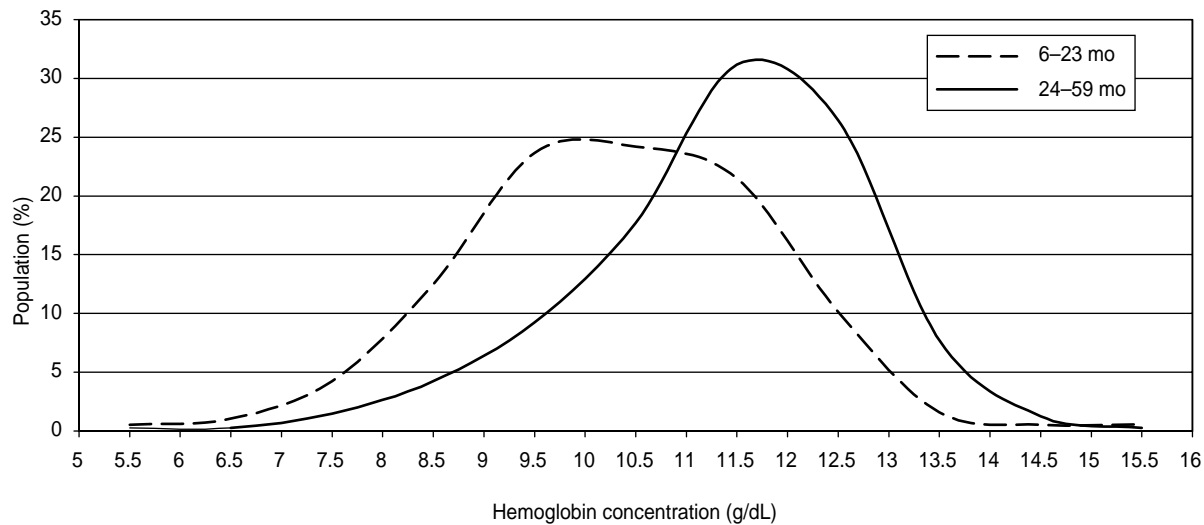
a lower limit of normality of about 11 g/dL (17–19). These studies, however, also reveal a slow but gradual rise in hemoglobin concentration, starting from the age of 3 months. Dallman and Siimes (19) reported that at 6 months of age, the lower level of normality is 11.1 g/dL, increasing to 11.3 g/dL at 59 months. Had we used a cutoff of 11.2 g/dL (instead of 11.0 g/dL) for the age group of 24–59 months, the prevalence of anemia in this age group would be 33.3%, rather than the 31.0% reported in Table 1. This is a relatively small effect. A difference of 0.2 g/dL between the two age groups, however, may be conservative, as larger changes with age were found by Brault et al. (17). Sherriff et al. (20) have recently suggested 10 g/dL as the cutoff for anemia in children aged 12–18 months, based on the fifth centile for a large cohort of children in the United Kingdom. Their sample, however, did not exclude iron-deficient children, and the data may be unrepresentative of normal nonanemic populations (18).

Even if age-specific cutoffs were to be used, this does not solve the problem of assessing the true prevalence of anemia, as no single cutoff at any age can distinguish anemic from nonanemic individuals. This is because the hemoglobin distribution curves of anemic and nonanemic subjects overlap.

Thus some anemic individuals have hemoglobin concentrations in the normal range and will not be diagnosed, whereas some normal individuals will be misclassified as anemic (21). For these reasons, additional indicators of deficiency have been advocated, such as serum ferritin, transferrin saturation, and erythrocyte protoporphyrin (21–23). When multiple indicators of iron status are used, anemia prevalence estimates are lower (24). Multiple indicators, however, are unusual in large population surveys.

Race-specific cutoffs have been suggested (25), blacks having hemoglobin concentrations about 0.5 g/dL lower than whites and Orientals (25–27). In Pernambuco, the population is mostly of mixed heritage, with no obvious differences in racial composition in the different parts of the state. Whether a lower cutoff is appropriate for this mixed-race population is not known.

Despite the difficulties in assessing anemia, we feel confident that the high prevalence of anemia in Pernambuco is real, and thus interventions are warranted. The urgency is particularly great among rural children and those 6–24 months old.

One potential intervention is to use iron and fortify the milk currently distributed through the national assistance program for malnourished preg-

nant women and children. In the city of São Paulo, the provision of milk fortified with iron and vitamin C to children 6–18 months old was associated with a reduction in anemia from 72.6% to 38.9% after 3 months, and a further reduction to 18.5% after 6 months (28). The national program, however, has limited outreach since it is restricted to children below the 10th centile weight-for-age. Fortifying other foods presents problems, especially where subsistence farming is practiced and few commercially processed foods are purchased. For the few foods that are commonly purchased, such as sugar, many small factories are involved and so it is difficult to have a centralized system of fortification. Another potential intervention is to provide iron supplements through community-based projects (29–31).

Educational interventions have the potential of being a cost-effective approach for improving the diets of young children (32). The aim would be to increase the variety of foods consumed—particularly foods rich in iron—as well as the consumption of foods containing vitamin C at every meal (33). Cooking in iron pots is no longer common in Pernambuco, but it could be encouraged (34, 35). Worm burdens among those under the age of 5 years are not known, but in four

small villages in rural Pernambuco 82% of inhabitants above the age of 1 year had *Schistosoma mansoni*, 80% had hookworm, and 70% had *Trichuris trichiura* (12). These parasites cause blood and iron to be lost in the stool and thus can contribute to anemia. Research to determine the prevalence of intestinal parasites among children in urban and rural areas of Pernambuco is warranted. If such parasites are found to be common, then interventions should be implemented, particu-

larly deworming and improved excreta disposal.

In summary, this research has highlighted anemia in the state of Pernambuco as a problem of public health importance requiring urgent action. Further research is necessary to determine which of the potential interventions is best suited to address the needs we have identified, particularly those of rural residents, who have more limited access to health care delivery systems.

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RESUMEN

Prevalencia de la anemia en niños de 6 a 59 meses en el estado de Pernambuco, Brasil

Objetivos. Determinar la prevalencia de la anemia en niños de 6 a 59 meses en Pernambuco, un estado del nordeste de Brasil, con el fin de ayudar a establecer las políticas de salud y nutrición.

Métodos. En 1997 se determinaron las concentraciones de hemoglobina en una muestra representativa de 777 niños. El proceso de muestreo se realizó en tres fases. Primero se seleccionaron aleatoriamente 18 municipios representativos del estado y de sus tres zonas geográficas (la región metropolitana de Recife, el interior urbano y el interior rural). A continuación, utilizando las listas del censo, se seleccionaron aleatoriamente 45 sectores censales. Finalmente, se seleccionaron 777 niños de 6 a 59 meses de edad. La sangre se recogió por punción venosa y la hemoglobina se midió con un hemoglobinómetro portátil. En el análisis, la prevalencia fue ponderada en función de la distribución de edad del censo.

Resultados. La prevalencia de la anemia entre los niños de 6 a 59 meses fue del 40,9% en todo el estado, del 39,6% en el área metropolitana de Recife, del 35,9% en el interior urbano y del 51,4% en el interior rural. La prevalencia fue dos veces mayor en los niños de 6 a 23 meses que en los de 24 a 59 meses: 61,8% frente a 31,0% ($\chi^2 = 77,9$, $P < 0,001$). Las concentraciones medias (± una desviación estándar) de hemoglobina en estos dos grupos fueron de $10,4 \pm 1,5$ y $11,4 \pm 1,4$ g/dL, respectivamente. La prevalencia no mostró diferencias estadísticamente significativas entre los dos sexos.

Conclusiones. Este ha sido el primer estudio de ámbito estatal realizado en Brasil sobre la prevalencia de la anemia en niños pequeños. La muy alta prevalencia de la anemia en los niños estudiados en Pernambuco, especialmente en los del grupo de 6 a 23 meses, requiere intervenciones de salud pública.